Accelerated Catalyst Aging and Poisoning

Background

Today, passenger car and truck engines must meet the combined requirements of increasingly strict environmental requirements and improved fuel economy. Virtually all engines will use a catalyst in a system to allow optimum fuel economy with reduced emissions. Catalyst durability is critical to the long term durability and performance of this system. Long-term durability tests are commonly run for final system verification, but are expensive and time consuming during system design and development. Rapid aging and poisoning techniques have been used in the past for developing more robust catalysts, mainly in the areas of automotive three-way catalysts. These techniques need to be extended to the new catalysts and modified lube oils and fuels needed for advanced combustion low emissions diesel engines. These rapid aging and poisoning techniques rely on accelerated test methods combined with extensive materials characterization to determine the mechanisms of degradation and to correlate results to long term tests.

Experimental engine-based aging apparatus (right); catalyst and holder (left)

The Technology

The Oak Ridge National Laboratory (ORNL) has developed accelerated aging and poisoning techniques for high temperature thermal cycling of lean oxides of nitrogen (NOx) traps (LNT) and for phosphorous poisoning

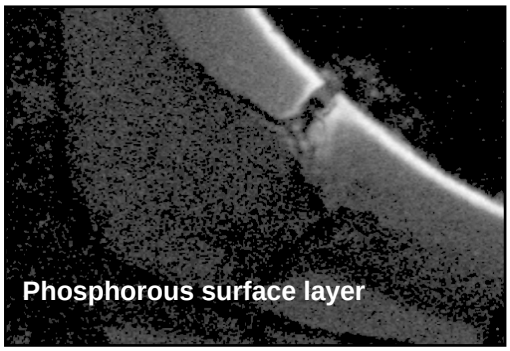
Benefits

- More rapid development and verification of catalyst emissions reduction systems
- More robust engine/catalyst systems
- Improved engine/catalyst system performance
- Simultaneous improvement in fuel economy and reduction of emissions

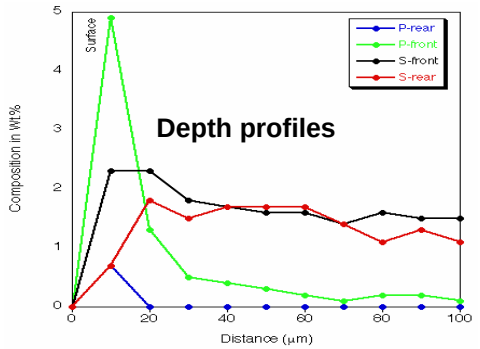
of diesel oxidation catalysts (DOC). These techniques simulate desulfation damage of LNTs and long-term poisoning of DOCs with lube oil phosphorous. Materials characterization has helped identify deterioration mechanisms such as surface layer phosphorous, sintering of precious metal, and phase change of alumina. The tests are conducted at accelerated rates up to 700 times normal service and on reduced-size samples. This approach has allowed rapid sample turn-around and a large number of experiments to be conducted.

Commercialization

As the rapid aging and poisoning techniques are further developed and verified, they can be used by catalyst manufacturers, lubricant manufacturers, and engine companies in product development. The techniques will be published in open literature so that they can be duplicated easily and tests can be run at ORNL under various contract arrangements. ORNL has received continued assistance from several companies in the research to date, indicating a high degree of interest in the results. ORNL is also taking steps to obtain used, field-returned catalysts in order to verify that the materials changes from the rapid tests duplicate those found in actual service. Further research is also being conducted in exhaust characterization as it relates to phosphorous poisoning in order to develop a link between exhaust composition and poisoning. This research will further shorten the development cycle because engine and exhaust conditions can be screened by rapid chemical measurements.



Representative results from rapid aging and poisoning studies



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